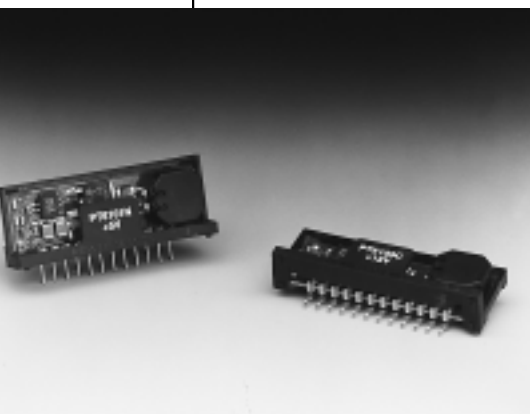# PT6100 Series

1 AMP ADJUSTABLE POSITIVE STEP-DOWN INTEGRATED SWITCHING REGULATOR

Revised 5/15/98

- 90% Efficiency
- Adjustable Output Voltage
- Internal Short Circuit Protection
- Over-Temperature Protection
- On/Off Control (Ground Off)
- Small SIP Footprint
- Meets Requirements for FCC Part 15; Class B limits for Radiated Emissions
- Wide Input Range

The PT6100 Series is a line of High-Performance 1 Amp, 12-Pin SIP (Single In-line Package) Integrated Switching Regulators (ISRs) designed to meet the on-board power conversion needs of battery powered or other equipment requiring high efficiency and small size. This high performance ISR family offers a unique combination of features combining 90% typical efficiency with open-collector on/off control and adjustable output voltage. Quiescent current in the shutdown mode is less than 100μA.

Standard Application

C_1 = Optional 1μF ceramic
Q_1 = NFET
C_2 = Required 100μF electrolytic
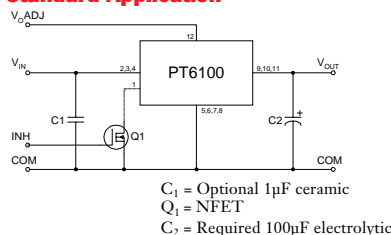
Pin-Out Information

Pin	Function
1	Inhibit (30V max)
2	V_{in}
3	V_{in}
4	V_{in}
5	GND
6	GND
7	GND
8	GND
9	V_{out}
10	V_{out}
11	V_{out}
12	V_{out} Adj

Ordering Information

PT6101□ = +5 Volts
PT6102□ = +3.3 Volts
PT6103□ = +12 Volts

Pkg Style 200

PT Series Suffix (PT1234X)

Case/Pin Configuration

Vertical Through-Hole	**N**
Horizontal Through-Hole	**A**
Horizontal Surface Mount	**C**

Specifications
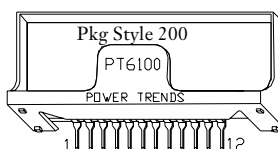
| Characteristics (T$_a$=25°C unless noted)	Symbols	Conditions		PT6100 SERIES			Units
				Min	Typ	Max	
Output Current	I_o	Over V_{in} range		0.1*	—	1.0	A
Short Circuit Current	I_{sc}	V_{in} = V_{in} min		—	3.5	—	Apk
Input Voltage Range (*Note: inhibit function cannot be used with Vin above 30V.*)	V_{in}	$0.1 \leq I_o \leq 1.0$ A	V_o = 3.3V V_o = 5V V_o = 12V	9 9 16	— — —	26 30/38** 30/38**	V V V
Output Voltage Tolerance	ΔV_o	Over V_{in} Range, I_o = 1.0 A T_a = 0°C to +60°C		—	±1.0	±2.0	%V_o
Line Regulation	Reg$_{line}$	Over V_{in} range		—	±0.25	±0.5	%V_o
Load Regulation	Reg$_{load}$	$0.1 \leq I_o \leq 1.0$ A		—	±0.25	±0.5	%V_o
V_o Ripple/Noise	V_n	V_{in}=V_{in} min, I_o=1.0 A		—	±2	—	%V_o
Transient Response with C_o = 100μF	t_{tr} V_{os}	50% load change V_o over/undershoot		— —	100 5.0	200 —	μSec %V_o
Efficiency	η	V_{in}=9V, I_o=0.5A, V_o=3.3V V_{in}=9V, I_o=0.5A, V_o=5V V_{in}=16V, I_o=0.5A, V_o=12V		— — —	84 89 91	— — —	% % %
Switching Frequency	f_o	Over V_{in} and I_o ranges		400	500	600	kHz
Shutdown Current	I_{sc}	V_{in} = 15V		—	100	—	μA
Quiescent Current	I_{nl}	I_o = 0A, V_{in} =10V		—	10	—	mA
Output Voltage Adjustment Range	V_o	Below V_o Above V_o		See Application Notes.			
Absolute Maximum Operating Temperature Range	T_a			-40	—	+85	°C
Recommended Operating Temperature Range	T_a	Free Air Convection, (40-60LFM) V_{in}=24V, I_o=0.75A	V_o= 3.3V V_o= 5V V_o= 12V	-40 -40 -40	— — —	+85*** +85*** +80***	°C
Thermal Resistance	θ_{ja}	Free Air Convection (40-60LFM)	V_o = 3.3V V_o = 5V V_o = 12V	— — —	50 40 40	— — —	°C/W
Storage Temperature	T_s			-40	—	+125	°C
Mechanical Shock		Per Mil-STD-883D, Method 2002.3 1 msec, Half Sine, mounted to a fixture		—	500	—	G's
Mechanical Vibration		Per Mil-STD-883D, Method 2007.2 20-2000 Hz, Soldered in a PC board		—	10	—	G's
Weight				—	5.0	—	grams

* ISR will operate down to no load with reduced specifications.
** Input voltage cannot exceed 30V when the inhibit function is used.   ***See Thermal Derating chart.
**Note:** *The PT6100 Series requires a 100μF electrolytic or tantalum output capacitor for proper operation in all applications.*

PT6100 Series

CHARACTERISTIC DATA

PT6102, 3.3 VDC
(See Note 1)

Efficiency vs Output Current
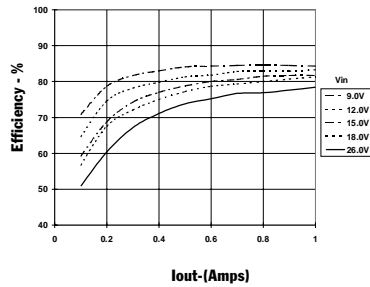
Ripple vs Output Current
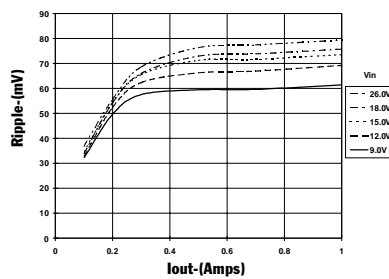
Thermal Derating (T$_a$) (See Note 2)
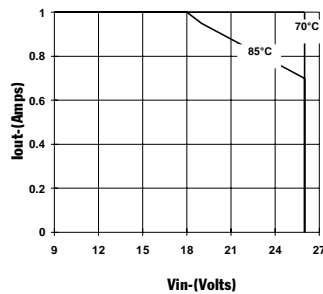
Power Dissipation vs Output Current
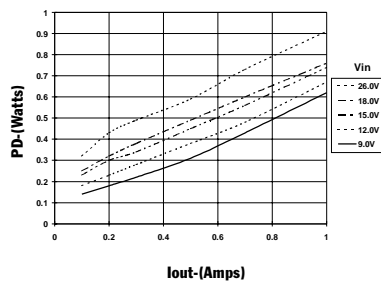
PT6101, 5.0 VDC
(See Note 1)

Efficiency vs Output Current
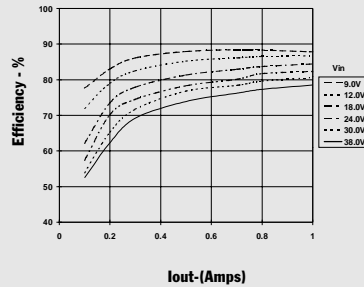
Ripple vs Output Current
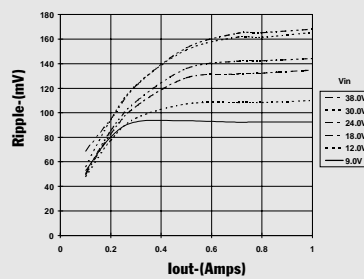
Thermal Derating (T$_a$) (See Note 2)
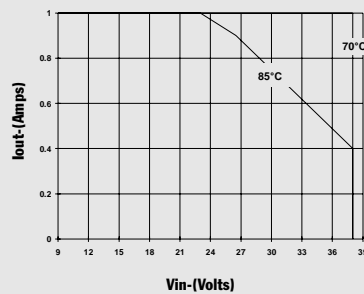
Power Dissipation vs Output Current
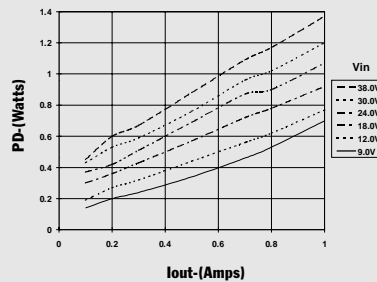
PT6103, 12.0 VDC
(See Note 1)

Efficiency vs Output Current
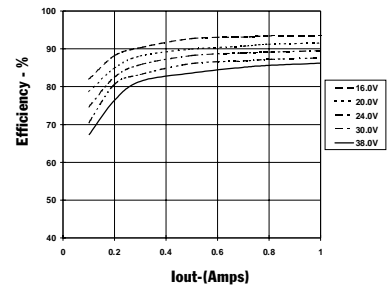
Ripple vs Output Current
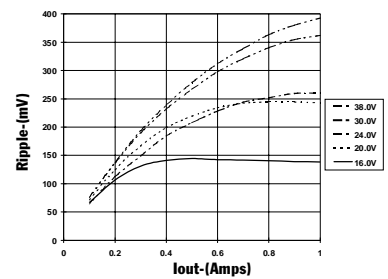
Thermal Derating (T$_a$) (See Note 2)
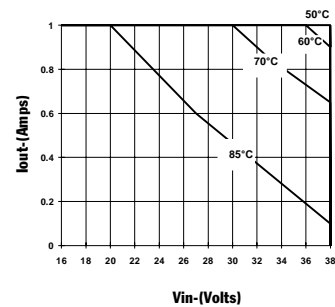
Power Dissipation vs Output Current
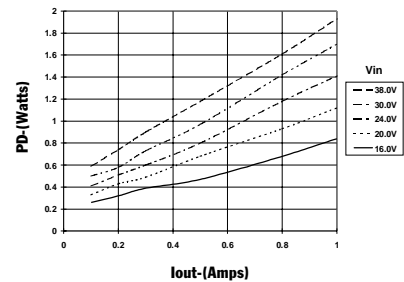
Note 1: *All data listed in the above graphs, except for derating data, has been developed from actual products tested at 25°C. This data is considered typical data for the ISR.*
Note 2: *Thermal derating graphs are developed in free air convection cooling of 40-60 LFM. (See Thermal Application Notes.)*

Application   Notes

Adjusting the Output Voltage of the Wide Input Range Bus ISRs

The output voltage of the Power Trends' Wide Input Range Series ISRs may be adjusted higher or lower than the factory trimmed pre-set voltage with the addition of a single external resistor. Table 1 accordingly gives the allowable adjustment range for each model for either series as V_a (min) and V_a (max).

Adjust Up: An increase in the output voltage is obtained by adding a resistor R2, between pin 12 (V_o adjust) and pins 5-8 (GND).

Adjust Down: Add a resistor (R1), between pin 12 (V_o adjust) and pins 9-11(V_{out}).

Refer to Figure 1 and Table 2 for both the placement and value of the required resistor; either (R1) or R2 as appropriate.

Notes:

1. Use only a single 1% resistor in either the (R1) or R2 location. Place the resistor as close to the ISR as possible.

2. Never connect capacitors from V_o adjust to either GND or V_{out}. Any capacitance added to the V_o adjust pin will affect the stability of the ISR.

4. Adjustments to the output voltage may place additional limits on the maximum and minimum input voltage for the part. The revised maximum and minimum input voltage limits must comply with the following requirements. Note that the minimum input voltage limits are also model dependant.

V_{in} (max)   = (8 x V_a)V or *30/38V, whichever is less.

PT6x0x/PT6x1x series:
V_{in} (min)   = (V_a + 4)V or 9V, whichever is highest.

PT6x2x series:
V_{in} (min)   = (V_a + 2.5)V or 7.5V, whichever is highest.

* Limit is 30V when inhibit function is used.

Figure 1
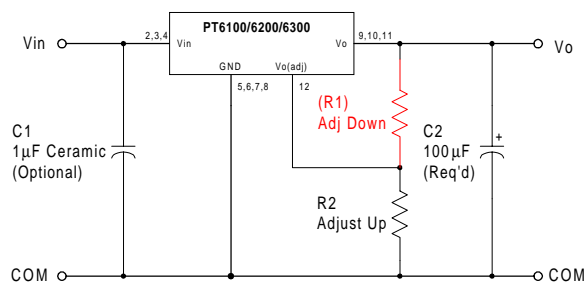
The values of (R1) [adjust down], and R2 [adjust up], can also be calculated using the following formulae.

$$(R1) = \frac{R_o (V_a - 1.25)}{V_o - V_a} \quad k\Omega$$

$$R2 = \frac{1.25\, R_o}{V_a - V_o} \quad k\Omega$$

Where: V_o = Original output voltage
V_a = Adjusted output voltage
R_o = The resistance value from Table 1

Table 1

ISR ADJUSTMENT RANGE AND FORMULA PARAMETERS

1Adc Rated	PT6102	PT6101		PT6103
	PT6122	PT6121		
2Adc Rated	PT6213		PT6212	PT6214
	PT6223		PT6222	
3Adc Rated	PT6303		PT6302	PT6304
	PT6323		PT6322	
V_O (nom)	3.3	5.0	5.0	12.0
V_a (min)	1.89	1.88	2.18	2.43
V_a (max)	6.07	11.25	8.5	22.12
R_O (kΩ)	66.5	150.0	90.9	243.0

Table 2

ISR ADJUSTMENT RESISTOR VALUES

	PT6102	PT6101		PT6103
1Adc Rated	PT6122	PT6121		
2Adc Rated	PT6213		PT6212	PT6214
	PT6223		PT6222	
3Adc Rated	PT6303		PT6302	PT6304
	PT6323		PT6322	
V_o (nom)	3.3	5.0	5.0	12.0
V_a (req.d)				
1.9	(30.9)kΩ	(31.5)kΩ		
2.0	(38.4)kΩ	(37.5)kΩ		
2.1	(47.1)kΩ	(44.0)kΩ		
2.2	(57.4)kΩ	(50.9)kΩ	(30.8)kΩ	
2.3	(69.8)kΩ	(58.3)kΩ	(35.4)kΩ	
2.4	(85.0)kΩ	(66.3)kΩ	(40.2)kΩ	
2.5	(104.0)kΩ	(75.0)kΩ	(45.5)kΩ	(32.0)kΩ
2.6	(128.0)kΩ	(84.4)kΩ	(51.1)kΩ	(34.9)kΩ
2.7	(161.0)kΩ	(94.6)kΩ	(57.3)kΩ	(37.9)kΩ
2.8	(206.0)kΩ	(106.0)kΩ	(64.0)kΩ	(40.9)kΩ
2.9	(274.0)kΩ	(118.0)kΩ	(71.4)kΩ	(44.1)kΩ
3.0	(388.0)kΩ	(131.0)kΩ	(79.5)kΩ	(47.3)kΩ
3.1	(615.0)kΩ	(146.0)kΩ	(88.5)kΩ	(50.5)kΩ
3.2	(1300.0)kΩ	(163.0)kΩ	(98.5)kΩ	(53.8)kΩ
3.3		(181.0)kΩ	(110.0)kΩ	(57.3)kΩ
3.4	831.0kΩ	(202.0)kΩ	(122.0)kΩ	(60.8)kΩ
3.5	416.0kΩ	(225.0)kΩ	(136.0)kΩ	(64.3)kΩ
3.6	227.0kΩ	(252.0)kΩ	(153.0)kΩ	(68.0)kΩ
3.7	208.0kΩ	(283.0)kΩ	(171.0)kΩ	(71.7)kΩ
3.8	166.0kΩ	(319.0)kΩ	(193.0)kΩ	(75.6)kΩ
3.9	139.0kΩ	(361.0)kΩ	(219.0)kΩ	(79.5)kΩ
4.0	119.0kΩ	(413.0)kΩ	(250.0)kΩ	(83.5)kΩ
4.1	104.0kΩ	(475.0)kΩ	(288.0)kΩ	(87.7)kΩ
4.2	92.4kΩ	(533.0)kΩ	(335.0)kΩ	(91.9)kΩ
4.3	83.1kΩ	(654.0)kΩ	(396.0)kΩ	(96.3)kΩ
4.4	75.6kΩ	(788.0)kΩ	(477.0)kΩ	(101.0)kΩ
4.5	69.3kΩ	(975.0)kΩ	(591.0)kΩ	(105.0)kΩ
4.6	63.9kΩ	(1260.0)kΩ	(761.0)kΩ	(110.0)kΩ
4.7	59.4kΩ	(1730.0)kΩ	(1050.0)kΩ	(115.0)kΩ
4.8	55.4kΩ		(1610.0)kΩ	(120.0)kΩ
4.9	52.0kΩ			(125.0)kΩ
5.0	48.9kΩ			(130.0)kΩ
5.1	46.2kΩ	1880.0kΩ	1140.0kΩ	(136.0)kΩ
5.2	43.8kΩ	937.0kΩ	568.0kΩ	(141.0)kΩ
5.3	41.6kΩ	625.0kΩ	379.0kΩ	(147.0)kΩ
5.4	39.6kΩ	469.0kΩ	284.0kΩ	(153.0)kΩ
5.5	37.8kΩ	375.0kΩ	227.0kΩ	(159.0)kΩ
5.6	36.1kΩ	313.0kΩ	189.0kΩ	(165.0)kΩ
5.7	34.6kΩ	268.0kΩ	162.0kΩ	(172.0)kΩ
5.8	33.3kΩ	234.0kΩ	142.0kΩ	(178.0)kΩ
5.9	32.0kΩ	208.0kΩ	126.0kΩ	(185.0)kΩ
6.0	30.8kΩ	188.0kΩ	114.0kΩ	(192.0)kΩ

R1 = (Red)   R2 = Black

ISR ADJUSTMENT RESISTOR VALUES (Cont)

	PT6101		PT6103
1Adc Rated	PT6121		
2Adc Rated		PT6212	PT6214
		PT6222	
3Adc Rated		PT6302	PT6304
		PT6322	
V_o (nom)	5.0	5.0	12.0
V_a (req.d)			
6.2	156.0kΩ	94.7kΩ	(207.0)kΩ
6.4	134.0kΩ	81.2kΩ	(223.0)kΩ
6.6	117.0kΩ	71.0kΩ	(241.0)kΩ
6.8	104.0kΩ	63.1kΩ	(259.0)kΩ
7.0	93.8kΩ	56.8kΩ	(279.0)kΩ
7.2	85.2kΩ	51.6kΩ	(301.0)kΩ
7.4	78.1kΩ	47.3kΩ	(325.0)kΩ
7.6	72.1kΩ	43.7kΩ	(351.0)kΩ
7.8	67.0kΩ	40.6kΩ	(379.0)kΩ
8.0	62.5kΩ	37.9kΩ	(410.0)kΩ
8.2	58.6kΩ	35.5kΩ	(444.0)kΩ
8.4	55.1kΩ	33.4kΩ	(483.0)kΩ
8.6	52.1kΩ		(525.0)kΩ
8.8	49.3kΩ		(573.0)kΩ
9.0	46.9kΩ		(628.0)kΩ
9.5	41.7kΩ		(802.0)kΩ
10.0	37.5kΩ		(1060.0)kΩ
10.5	34.1kΩ		(1500.0)kΩ
11.0	31.3kΩ		
11.5			
12.0			
12.5			608.0kΩ
13.0			304.0kΩ
13.5			203.0kΩ
14.0			152.0kΩ
14.5			122.0kΩ
15.0			101.0kΩ
15.5			86.8kΩ
16.0			75.9kΩ
16.5			67.5kΩ
17.0			60.8kΩ
17.5			55.2kΩ
18.0			50.6kΩ
18.5			46.7kΩ
19.0			43.4kΩ
19.5			40.5kΩ
20.0			38.0kΩ
20.5			35.7kΩ
21.5			33.8kΩ
21.5			32.0kΩ
22.0			30.4kΩ

IMPORTANT NOTICE

Texas Instruments and its subsidiaries (TI) reserve the right to make changes to their products or to discontinue any product or service without notice, and advise customers to obtain the latest version of relevant information to verify, before placing orders, that information being relied on is current and complete. All products are sold subject to the terms and conditions of sale supplied at the time of order acknowledgement, including those pertaining to warranty, patent infringement, and limitation of liability.

TI warrants performance of its semiconductor products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are utilized to the extent TI deems necessary to support this warranty. Specific testing of all parameters of each device is not necessarily performed, except those mandated by government requirements.

CERTAIN APPLICATIONS USING SEMICONDUCTOR PRODUCTS MAY INVOLVE POTENTIAL RISKS OF DEATH, PERSONAL INJURY, OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE ("CRITICAL APPLICATIONS"). TI SEMICONDUCTOR PRODUCTS ARE NOT DESIGNED, AUTHORIZED, OR WARRANTED TO BE SUITABLE FOR USE IN LIFE-SUPPORT DEVICES OR SYSTEMS OR OTHER CRITICAL APPLICATIONS. INCLUSION OF TI PRODUCTS IN SUCH APPLICATIONS IS UNDERSTOOD TO BE FULLY AT THE CUSTOMER'S RISK.

In order to minimize risks associated with the customer's applications, adequate design and operating safeguards must be provided by the customer to minimize inherent or procedural hazards.

TI assumes no liability for applications assistance or customer product design. TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right of TI covering or relating to any combination, machine, or process in which such semiconductor products or services might be or are used. TI's publication of information regarding any third party's products or services does not constitute TI's approval, warranty or endorsement thereof.